Modeling Ocean Mixed Layer Flow Under Multiple Lead Fields in Sea Ice

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LONG-TERM GOAL

A major goal of my current high latitude oceanographic research is to improve understanding of thermodynamic coupling of the atmosphere and ocean when sea ice is present. Improved understanding of the physical processes will ultimately lead to improved parameterization of small scale processes in larger scale general circulation models and thus to a better assessment of the role of the Arctic Ocean in climate change.

OBJECTIVES

Leads are small scale cracks in sea ice where important buoyancy flux processes occur between the Arctic atmosphere and ocean. They represent a small percentage of overall ice extent and are subgrid scale phenomena for Arctic general circulation models. Because of their subgrid scale nature, the impact of these important air sea fluxes must be parameterized in the larger models. The goal of this research is to develop a better understanding of Arctic Ocean mixed layer modification by buoyancy flux from multiple leads in sea ice.

APPROACH

A high resolution numerical model, in conjunction with coordinated laboratory experimentation, is used to examine convectively driven circulation in the shallow Arctic mixed layer. The nonhydrostatic numerical model (reported in Smith and Morison, 1998) has been used to examine mixed layer circulations under stationary and moving winter lead buoyancy sources. An important consideration in recently evolving nonhydrostatic ocean models of this type is the subgrid scale mixing parameterization used. An assessment of the importance of these schemes can be found by careful comparison of numerical results with comparable laboratory experiments. This type of comparison (Lavelle and Smith, 1996) has shown that the importance of the subgrid scale mixing scheme in getting agreement between numerical and lab results.

WORK COMPLETED

Based on the conclusions of Lavelle and Smith (1996) it was decided to reexamine the results reported in Smith and Morison (1998) with an improved representation of the subgrid scale mixing. That model has thus been recently modified to incorporate Smagorinsky mixing that was also used in the Lavelle and Smith study. New experiments are presently being explored. Figure 1 shows a preliminary simulation of circulation under two adjacent stationary leads and the associated Smagorinsky mixing.

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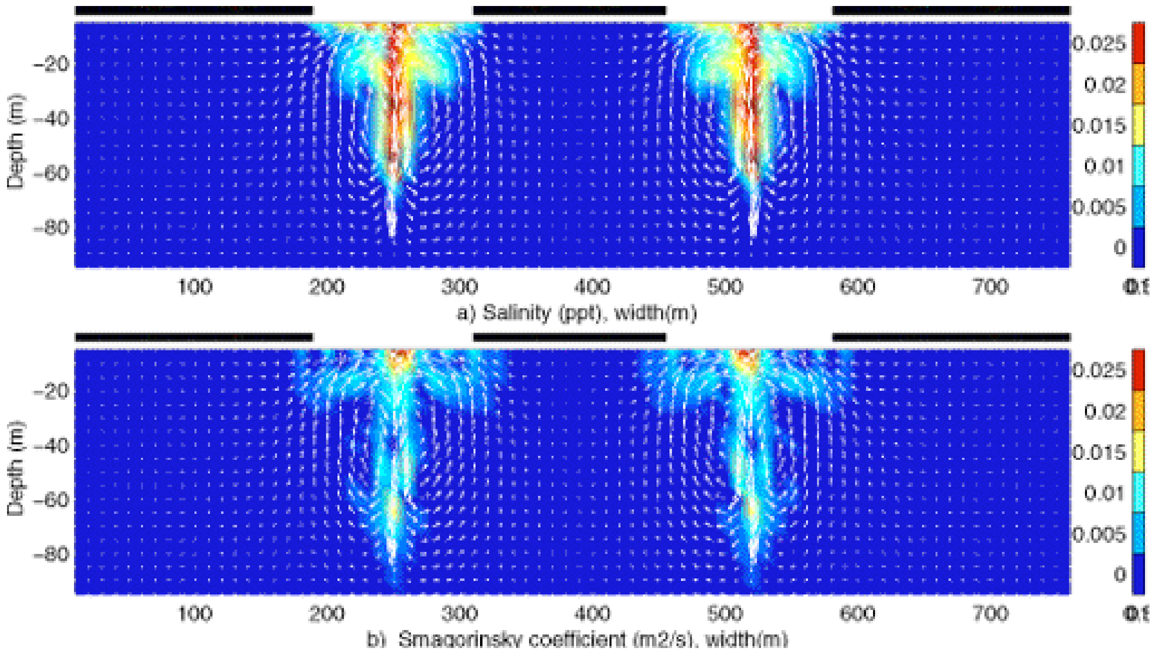

Figure 1

RESULTS

This being my first year at ASU, I am still exploring the means by which numerical and laboratory intercomparison can aid in understanding of physical processes and ocean model representation of these. An overview paper exploring this approach of small scale mixing processes in lab and numerical studies has been submitted (Fernando and Smith,1998) upon we will build our future intercomparisons.

IMPACT/IMPLICATIONS

It is hoped that this type of lab/numerical experimentation will lead to the improved parameterization of small scale air sea buoyancy flux in Arctic Ocean general circulation models. I have been in contact with researchers at NCAR who work with these types of models in hopes of establishing a direct link between this research and those who use those models.

TRANSITIONS RELATED PROJECTS

The descent of negatively buoyant fluid from distributed sources in laboratory experiments is presently being studied at ASU by Fernando and Colmer. Three dimensional, nonhydrostatic, high resolution numerical simulations are presently being executed for comparison with these experiments. We are contrasting numerical and lab experiments in both rotating and nonrotating systems.

REFERENCES

Lavelle W.J. and D.C.Smith, 1996:Effects of rotation on convective plumes from line segment sources. J.Phys.Oceanogr., 26,863-872.

PUBLICATIONS

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